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ABSTRACT

This report focuses on graduates in physics who did not earn any degrees after their bachelor's degree and who are not primarily students. The report is based on data from a sample of physics bachelors between December 1998 and the summer of 1999. About 1,200 respondents, out of a potential 2,400, supplied the information. At 5 to 8 years after graduating, only about one-third of people with bachelor's degrees in physics do not have any additional degrees. Three-fourths of these degree recipients work in science-related jobs, and the largest group are employed in software jobs. Thirty percent of these physics bachelors are still working in their first-career job path at 5 to 8 years after graduation. About 70% of those employed in engineering, mathematics, and science rate their physics preparation highly, but they do not rate their preparation in terms of scientific research experience, laboratory skills, and scientific software as highly. Sixty percent of the respondents say that they would major in physics again. (SLD)

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The Early Careers of Physics Bachelors

AIP Pub. Number R-433

American Institute of Physics

August 2002

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AIP REPORT

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The Early Careers of Physics Bachelors

HIGHLIGHTS

- Five to eight years after graduating, only about one-third of people who earned bachelor's degrees in physics do not have any additional degrees (**Figure 1**). This report focuses on this group—physics bachelors with no additional degrees who are not primarily students.

- Three-fourths of these physics bachelors work in science-related jobs, including software, engineering, high school teachers, and managers in technical fields. The largest group—about one-fourth—are employed in software jobs (**Table 1**). These physics bachelors graduated in the early 1990s during the rapid expansion of the IT industry.

- 30% of these physics bachelors are still working in their first career-path job five to eight years after graduation.

- Those who are employed in software jobs are much less likely to use the parts of their education that are exclusive to physics than those employed in engineering, math, and science jobs (**Figure 2**).

Table 1. Type of Employment of Physics Bachelors 5 to 8 Years After Graduation

Type of Job	Percent
Software	24
Engineering	19
Science & Lab Technician	9
Management, Owner & Finance	20
Education	12
Active Military	6
Service and Other Non-Technical	10

Based on physics bachelors with no additional degrees who are not primarily students.

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- About 70% of those employed in engineering, math, and science rate their physics preparation highly. However, they did not rate their preparation in terms of scientific research experience, lab skills, and scientific software as highly (**Figure 5**).

- There are some discrepancies between how much these physics bachelors say they use some skills and how well they felt prepared to use that skill. For example, most say that they spend a lot of time working with co-workers. However, they did not rate their undergraduate preparation in this area very highly (**Figure 6**).

- 60% of these physics bachelors say they would major in physics again.

Physics bachelors in the workforce have been called "hidden physicists," in the sense that they are often doing physics at their jobs, but are not called physicists. Their jobs may not be recognized as physics-related by their employers or even by themselves. For these "hidden physicists," the first few years in their careers are formative years. The choices physics bachelors make during these initial years can set them on a career-path that is later difficult to change. Five to eight years after graduation, most physics bachelors with no additional degrees have the same job title as their first career-path job. Therefore, physics departments have a potentially vital role to play in mentoring their undergraduate majors through the process of landing that first "real job."

This study marks the first time that AIP has studied the early careers of physics bachelors. Although we routinely collect data about the immediate situation of physics graduates, we had never before collected data about what physics bachelors are doing five to eight years after graduation.

This report is based on data collected from a sample of physics bachelors between December 1998 and the summer of 1999. We started with a random sample of 152 physics departments. The sample was stratified by department size and by type of department, so that it is representative of all types of physics departments. We then contacted each selected physics department and asked them to provide us with the names and addresses of their bachelor's degree recipients from 1991-93. One hundred forty-nine departments provided us with names and addresses, and we are very grateful to them. We had about 2400 addresses that were potentially good; that is, they were not returned by the post office. Of these, about 1200 responded to a very long questionnaire (16 pages) that asked for educational and job histories.

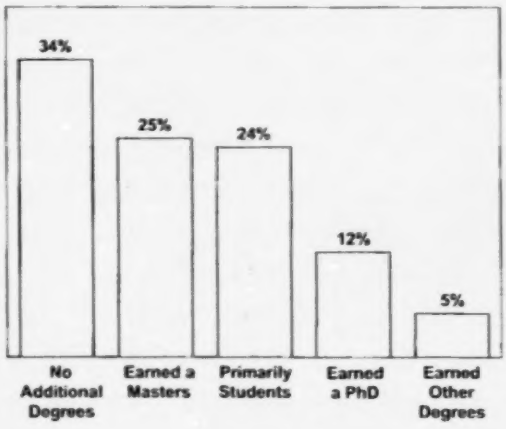
Opportunities of the early 1990s. The respondents described in this report all have physics bachelor's degrees but no additional degrees and are not primarily students. It is important to remember that they graduated in the early 1990s during a recession, and that this probably influenced their educational and career paths. Although our sample is representative of physics graduates from 1991-93, those who graduated during other years may well have had quite different experiences.

In spite of graduating in the midst of a recession, the physics bachelors who entered the workforce during the early 1990s were able to take advantage of the explosion of the IT industry and the Internet. Physics bachelors are not specifically trained to work in the software industry, but many of those who graduated during this time took advantage of the flexibility afforded them by a physics education, moved into software jobs, and are flourishing in these jobs. This flexibility is especially important to those who are the focus of this report, physics bachelors who have no additional degrees. Physics graduates usually have the tools they need to seize the opportunities that social and technological changes inevitably bring. These tools include the ability to think analytically and to solve problems—skills that physics graduates can use in any field.

EDUCATION

During physics undergraduate education, students acquire cognitive and research skills that allow them to pursue any graduate degree that they wish. Pursuing additional education is very common for the respondents in this study. **Figure 1** shows that five to eight years after graduation, one-fourth of physics bachelors have earned master's degrees, about one-fourth are still in school, and about one-eighth have a PhD. The remaining 5% have earned degrees other than PhD or master's. Among the 5% with other degrees, about 2% of the total have earned additional

Figure 1. Highest Degree Obtained by Physics Bachelors 5 to 8 Years After Graduation



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bachelor's degrees, about 2% have MDs, and about 1% have law degrees.

This report focuses on those who did not earn any degrees after their physics bachelor's degree and are not primarily students. This group makes up about one-third of our total respondents (**Figure 1**). Even among this group, additional schooling is very common. Two-fifths of those without additional degrees reported that they attended graduate or professional school with the intention of earning a degree (but did not complete the degree). About fifteen percent of those without additional degrees attended some sort of additional school without the intention of earning a degree. Of those with no additional degrees, about one-fourth are currently in school, but are not primarily students. They did not identify themselves as being primarily students, thus it is likely that they are taking classes part-time while maintaining a full-time job. In fact, out of nearly 1200 respondents, only about 15% never attended school after receiving their physics bachelor's degree.

Of those who attended school with the intention of getting a graduate degree but did not, a little more than 20% attended more than one school. Among those who intended to get graduate degrees but did not, 35% were in physics or astronomy, 26% were in engineering, 8% were in computer science, and 13% were in education. The remaining 18% were in various other fields.

We asked respondents how well physics education prepared them for graduate school. Those who attended physics graduate school with the intention of getting a degree, but did not, felt no less prepared than those who either completed graduate physics degrees or were still in physics graduate school at the time of the survey. Therefore, it is unlikely that they did not complete graduate physics degrees because they felt unprepared. It is possible that other opportunities presented themselves or they had some sort of personal situation that pushed them away from graduate school.

EMPLOYMENT

In spite of having graduated during a recession, there is very little unemployment among physics bachelors five to eight years later. Among those who did not receive any additional degrees and are not primarily students, 96% are currently employed. The majority of the unemployed are not looking for work, and most of these are stay at home mothers. Only two physics bachelor's with no additional degrees were unemployed and looking at the time of the survey.

A well-rounded physics education can be the key to employment in many different areas. Undergraduate physics education gives people cognitive skills, such as the ability to solve problems and to think critically and analytically. Such cognitive skills are highly adaptable in today's changing economy. Physics education also provides graduates with a set of technical skills including lab skills, math skills, and computer skills that can be used in a variety of careers. Three-fourths of the physics bachelors with no additional degrees took these skills and currently work in science-related jobs, including software, engineering, high school science/math teachers, and managers in technical fields. The largest group of physics bachelors with no additional degrees—about one-fourth—are employed in software jobs (**Table 1**). About one-fifth are employed as engineers, and nine percent are employed in other science-related jobs or as lab technicians. Twelve percent of the

Table 2. Change To and From Science-Related Jobs for Physics Bachelors

		Current Job*		Number of Respondents
		Non-Science	Science	
First Career Path Job	Non-Science	76%	24%	86
	Science	7%	93%	246

*Current job is job at time of survey, 5 to 8 years after graduation.

Based on physics bachelors with no additional degrees who are not primarily students.

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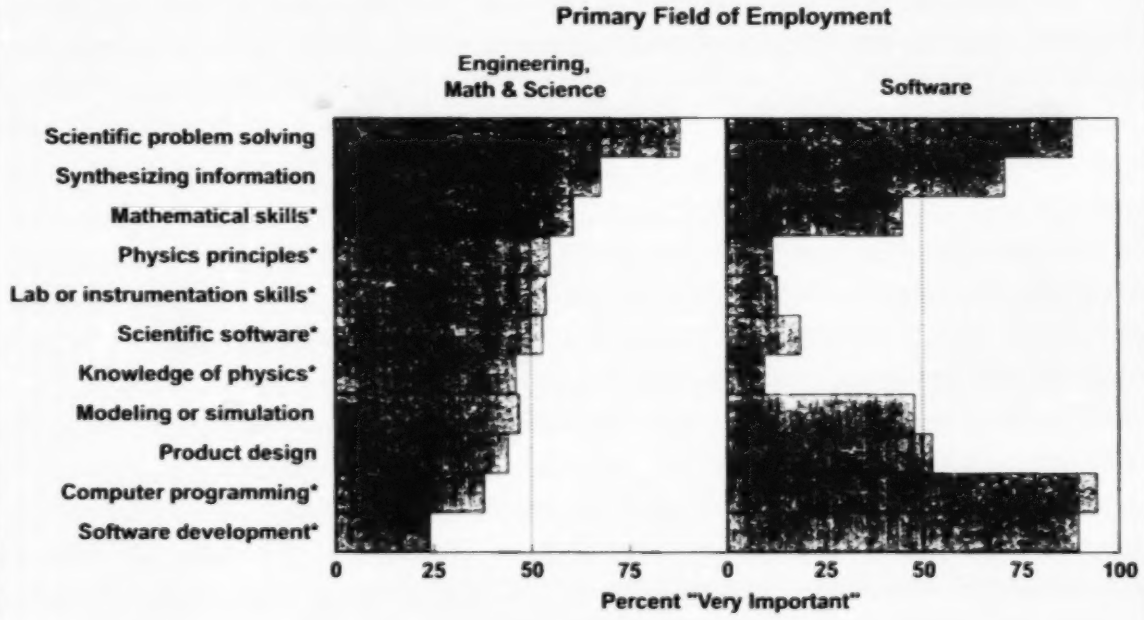
respondents are in education, and about 60% of these are high school science teachers.

A small percentage of the respondents hold various jobs as active military personnel. About one-fifth of respondents are managers. This group includes a few who own their own businesses or are in financial occupations, but most of them are managers in technical environments. In just a few years, these physics bachelors have done very well for themselves.

Ten percent of physics bachelors with no additional degrees who are not primarily students are in the "service and other non-technical" category. This category designates people who are in jobs in which they could have skipped not only their physics degree, but college altogether. They work in factories on assembly lines, work as repair people, and have jobs that do not require a college education. Some of the respondents in this group purposely chose such careers. Others originally thought these jobs would be temporary, but ended up liking them and decided to stay. But there is also a group that is clearly dissatisfied with their situation. They make comments such as "I wish I could have found a job in physics." It should be noted that some of the people working in software jobs made this remark, too.

The respondents described to us not only their current job, but also their first career-path job, which we defined as "a job that will help you in your future career or a job in the field in which you want to make your career." About three-fourths of physics bachelors with no additional degrees who are not primarily students were in science-related jobs for their first career-path jobs. **Table 2** shows the percentages of these respondents moving in and out of science-related jobs since their first career-path jobs. Almost all of those who started out in science-related jobs are still in science-related jobs, but a few did leave science. One-third of those who left science went into a financial occupation. Of

Figure 2. Knowledge and Skills Rated as Important by Physics Bachelors 5 to 8 Years After Graduation



These data reflect the percentage who chose 4 or 5 on a 5-point scale where 1 = completely unimportant and 5 = essential. Based on physics bachelors with no additional degrees who are not teachers or primarily students.

*Differences between the two fields of employment are significant at $\alpha \leq .05$

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those who started out in a non-science job, one-fourth were in a science-related job at the time of the survey. Almost two-thirds of those who transferred into science-related jobs went into software or engineering jobs.

We also examined mobility between first career-path job and current job for physics bachelors with no additional degrees who are not primarily students. About 60% of these physics bachelors have the same job title for their first career-path job and their current job. About half of these are still working in their first career-path job at the time of the survey, and the other half have the same job title at a different company. Thus, we can see that the first career-path job is very important, because a majority still have the same job title five to eight years later.

Of those who changed job titles between their first career-path job and their current job, about 45% started out as lab technicians or worked in other science jobs. As for the jobs they transferred into, about 35% of all those who changed job titles went into the manager, owner, and finance category.

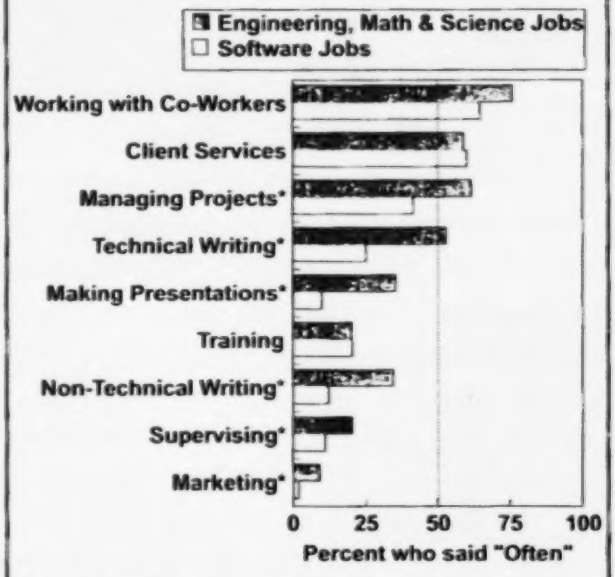
JOB ACTIVITIES

Physics bachelors are capable of doing a wide variety of tasks on the job, including some for which they receive no direct training as undergraduates. We have already seen how some physics bachelors were able to take advantage of the opportunities afforded to them by the rapidly expanding IT industry. But what exactly do physics bachelors do at their jobs? We showed respondents a list of eleven items and asked them to rate how important each was at their current jobs, using a five-point scale where "5" meant essential and "1" meant completely unimportant. This list was intended to include skills that physics bachelors may have learned as undergraduates, including problem-solving, lab skills, and physics principles. For physics bachelors with no additional degrees who are not primarily students, job title affects their rating of the items. **Figure 2** shows the percentages of respondents in two job categories who said that the items were "4" or "5" in importance. Most who work in engineering, math and science jobs think scientific problem solving is essential. They synthesize information, they use math and physics, they use lab skills, and they use scientific software. They are not engaged as much in programming and software development.

This is quite a contrast with those employed in software jobs, who also use scientific problem solving and synthesize information. However, they are much less likely to use math, physics, lab skills, and scientific software. They are much more likely to be engaged in programming and software development. Those who are employed in the software industry are much less likely to use the parts of their education that are exclusive to physics.

We also asked, in a separate question, how much time the respondents spent in a variety of activities on the job. While the first question included many skills that the respondents may have learned as undergraduates, this second question included more interpersonal items such as communication, providing services to clients, and supervising. On this question, "5" meant extensive time, and "1" meant none. **Figure 3** shows the percentages who answered "4" or "5" to the items. Again, those employed in engineering, math, and science gave

Figure 3. Time Spent on Job Activities by Physics Bachelors 5 to 8 Years After Graduation



These data reflect the percentage who chose 4 or 5 on a 5-point scale where 1 = none and 5 = extensive. Based on physics bachelors with no additional degrees who are not teachers or primarily students.

*Differences between the two fields of employment are significant at $\alpha \leq .05$.

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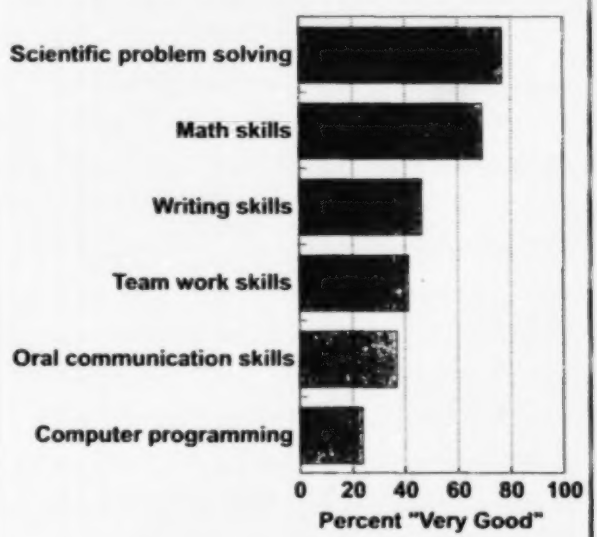
different responses than those employed in software. Respondents in both types of jobs work with co-workers and provide services to clients. However, the respondents employed in software jobs are much less likely to manage projects, write, make presentations, and supervise than those employed in engineering, math, and science. Hardly any of the respondents do marketing, although those employed in engineering, math, and science were more likely to do this than those employed in software.

Although those working in engineering, math, and science are more likely to say that they supervise others, those who work in software jobs are equally likely to say that they have hired bachelor's level employees. When those employed in software hired others, the most frequent major they hired was computer science. When those in engineering, math, and science hired others, the most frequent major they hired was engineering, but physics was a close second. Since engineering produces more majors than physics, it seems that physics bachelors working in engineering, math, and science jobs recognize the value of physics education and reward it in others.

Figure 4. Rating of Physics Bachelors' Education 5 to 8 Years After Graduation



These data reflect the percentage who chose 4 or 5 on a 5-point scale where 1 = terrible and 5 = excellent. Based on physics bachelors with no additional degrees who are not primarily students.

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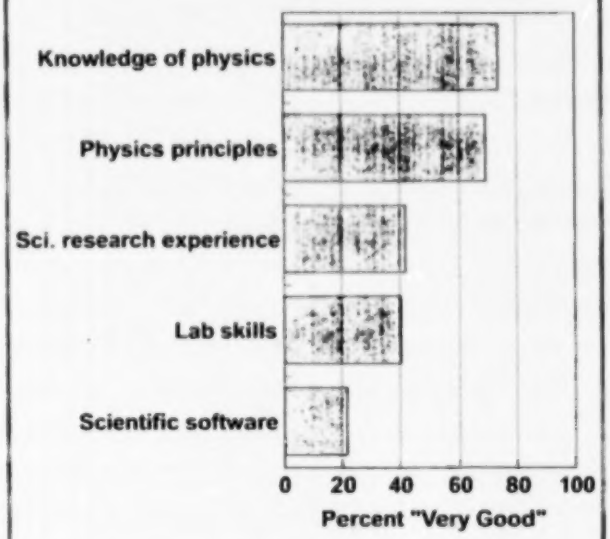
EVALUATION OF PHYSICS EDUCATION

How valuable is physics education to physics bachelors? While physics education does provide graduates with skills that they can use in almost any career, several respondents reported that they had trouble selling their degree and skills to prospective employers. Looking back, do physics bachelors think that majoring in physics was valuable preparation for a career? In a separate question, we asked respondents to rate their physics education in terms of the skills that they were likely to have learned as undergraduates. They could choose not to rate some of the areas if they did not use them in their careers. They were asked to rate each on a five-point scale where "5" meant excellent and "1" meant terrible. **Figure 4** shows, for the items that most of the respondents said that they use, the percentages who said "4" or "5." Most physics bachelors with no additional degrees who are not primarily students rate their problem solving and math skills highly. However, they did not rate writing, team work, and oral communication as highly, and programming received the fewest "4"s and "5"s.

Many of those employed in software jobs said that they do not use some of the aspects of physics education that we asked about, so they did not rate them. However, **Figure 5** shows how those employed in math, engineering, and science rated aspects of their physics education that they said they use. The bars represent the percentages who rated the items as "4" or "5" on a five-point scale, where "5" meant excellent. About 70% of those employed in engineering, math, and science rated their physics preparation highly. They were less enthusiastic, however, about their scientific research experience, their lab skills, and their experience with scientific software.

There are some discrepancies between how much respondents say they use some skills and how well they felt prepared to use those skills. **Figure 6** shows these discrepancies by showing the percentages of respondents who chose "4" or "5" on a five-point scale where "1" is low and "5" is high. The blue bars represent how important the respondents said the items were to their current jobs, and the gold bars represent how they rated their physics education in terms of preparing them to use the skill in their career. Most physics bachelors with no additional degrees who are not primarily students

Figure 5. Rating of Physics Bachelors' Education by Those who are Employed in Engineering, Math or Science



These data reflect the percentage who chose 4 or 5 on a 5-point scale where 1 = terrible and 5 = excellent. The respondents are not employed in academics or in software jobs, have no additional degrees and are not primarily students, 5 to 8 years after graduation.

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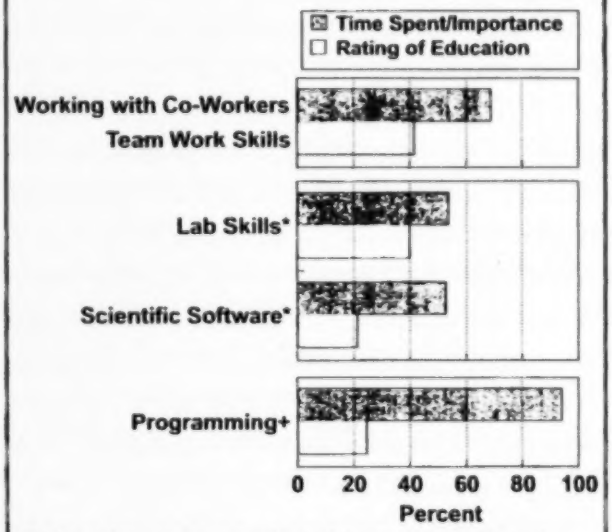
say that they spend a lot of time working with co-workers. However, they were less enthusiastic about how their education prepared them in terms of collaboration and team work skills. This is perhaps symptomatic of our educational system, which rewards individual achievement rather than collaborative efforts. Even when professors assign group activities or projects, it is very difficult to simulate the type of team environment encountered in the work place. This probably represents a challenge not only to physics education, but to the whole educational system.

As **Figure 6** also shows, those employed in engineering, math and science use lab skills and scientific software, but seem to feel their preparation could have been better in these areas. The big contrast is for those who are employed in software. They program extensively, but many are unlikely to rate their programming preparation as adequate. Unfortunately, with this survey, we are not able to tell with which aspects of programming they are dissatisfied. It could be that they wanted more time spent on programming, or it could be that they wanted experience with certain languages. However, this survey did not gather those data. We also do not know how exactly those employed in engineering, math, and science would want to improve their preparation with scientific software or with lab skills.

How satisfied are physics bachelors with their physics education? We also asked respondents to rate various aspects of their physics education, including the teaching, curriculum, and supportiveness of their professors. A positive departmental environment can go a long way in giving students the self-confidence they need to negotiate the job market and obtain that critical first career-path job. **Figure 7** shows the percentages of physics bachelors with no additional degrees who are not primarily students and who said that they were either "very satisfied" or "somewhat satisfied" with various aspects of their degree program. Overall, they were satisfied with their physics education in terms of curriculum, teaching, the professors, and other students. They were least

Figure 6. Time Spent on or Importance of Activities Compared to Rating of Physics Bachelors' Education



*Engineering, math and science jobs (but not teachers).
+Software jobs.

These data reflect the percentages who chose 4 or 5 on a 5-point scale. Based on physics bachelors with no additional degrees who are not primarily students, 5 to 8 years after graduation.

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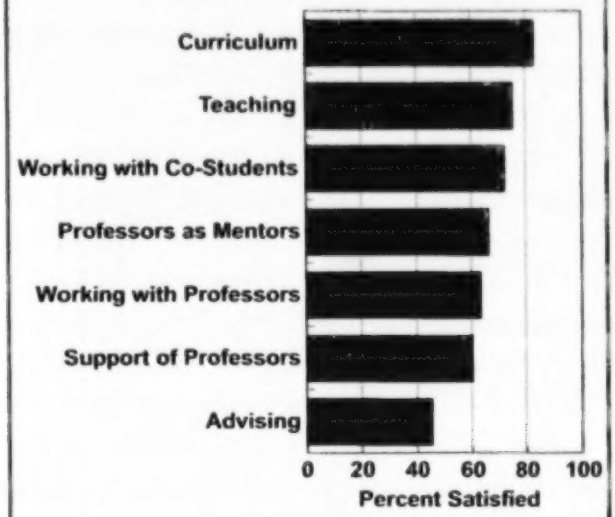
Figure 7. Satisfaction with Degree Program Among Physics Bachelors 5 to 8 Years After Graduation



These data reflect the percentage who chose 4 or 5 on a 5-point scale where 1 = very dissatisfied and 5 = very satisfied. Based on physics bachelors with no additional degrees who are not primarily students.

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satisfied with advising, but 45% were still satisfied with the advising they received. Those who are employed in service and other non-technical occupations are less likely to say that they are satisfied with the teaching in their physics courses. But on the other items, there is no difference between their level of satisfaction and that of the other respondents.

Another way to measure satisfaction with physics education is to ask the respondents if they would major in physics if they could do it all over again. We asked this question and gave the respondents a five-point scale to rate their answers, with "5" meaning "definitely would". In this study, 60% of physics bachelors with no additional degrees who are not primarily students answered either a "4" or a "5" on this scale. Five to eight years after their degrees, most see real value in their physics education. Even those in service occupations were as likely to say that they would major in physics again as those working in other fields. Thus, working in a job that does not use a physics degree does not make respondents less likely to say that they would major in physics again.

The National Science Foundation also asked this question of college graduates in a 1997 survey. Of those who have no higher than a bachelor's degree in physics and astronomy and graduated during the early 1990s, 50% said that they would be "very likely" to major in physics or astronomy again. About the same percentage of biological sciences graduates said they would "very likely" major in the same field, and about 45% of chemistry majors said that they would be "very likely" to major in chemistry again.

Physics bachelors with no additional degrees who are not primarily students mostly see their education in a positive light. They are using their scientific problem-solving skills. They synthesize information, which is an essential component of physics education. Their math skills have served them well. But they wish they had more preparation in working with others. Those employed in engineering, science, and math wish they had better preparation in terms of lab skills and scientific software. Many are employed in software jobs and are not using much of their strict physics training. However, we can say that the skills they learned as physics majors allowed these graduates to meet the challenges of a changing economy during the 1990s. We hope that the results of this study can be used by physics faculty to better evaluate how well they are preparing all of their graduates for the workplace.

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